current may be optionally measured for diagnostic purposes. Preferably the electronic circuitry is also capable of applying an AC waveform (e.g., 500 Hz or less) for capacitive or conductive measurements (as discussed above). Still further, the electronic circuitry may be configured to generate 20 kHz signals suitable for, e.g., hematocrit measurements of blood samples.

[0307] In one particularly preferred embodiment of the cartridge reader configured to perform luminescence based assays, the cartridge reader may employ an optical detector **2335**, e.g., a photodiode (most preferably, a cooled photodiode), photomultiplier tube, CCD detector, CMOS detector or the like, to detect and/or measure light/luminescence emanating from the read chambers. If a cooled photodiode is employed, a thermo-electric cooler and temperature sensor can be integrated into the photodiode package itself providing for selective control by the electronic control system.

[0308] A computerized control system **2310** is preferably utilized to selectively control operation of the cartridge-based system. The computerized control system may be fully integrated within the cartridge reader, separated from the cartridge reader in an externally housed system and/or partially integrated within and partially separated from, the cartridge reader. For example, the cartridge reader can be configured with external communications ports (e.g., RS-232, parallel, USB, IEEE 1394, and the like) for connection to a general purpose computer system (not shown) that is preferably programmed to control the cartridge reader and/or its subsystems. In one preferred embodiment, a single embedded microprocessor may be used to control the electronics and to coordinate cartridge operations. Additionally, the microprocessor may also support an embedded operator interface, connectivity and data management operations. The embedded operator interface can preferably utilize an integrated display **2360** and/or integrated data entry device **2355** (e.g., keypad). The computerized control system may also preferably include non-volatile memory storage for storing cartridge results and instrument configuration parameters.

[0309] FIG. **34** shows a cutaway exploded view of one preferred design for reader **2300** and also shows a cartridge drawer **2386** (preferably comprising an integrated cartridge heater) on linear guide **2384** and driven by motor **2380** for moving the cartridge in and out of the reader. FIG. **34** also shows fluid sensor array **2388** (holding sensors, preferably optical) for detecting fluid at selected positions in the cartridge and a motor **2382** for bringing the cartridge together with frame **2383** which supports the electrical connectors (not shown in this view), fluidic connectors (not shown in this view), ampoule breaking mechanism **2350** and light detector **2335**.

[0310] FIG. **24** illustrates a preferred configuration of valves in a cartridge reader fluidic handling sub-system configured for use with cartridge **2500** (analogous to cartridge **1400**) shown in the fluidic diagram of FIG. **25** (along with preferred locations for cartridge reader fluid detection sensors **1-15**). The sub-system comprises a pumping system that comprises a pneumatic pump (preferably, an air piston) linked to a pump manifold. The manifold is connected to control lines (comprising control valves **2412**A and **2412**B) that connect the pump to selected vent ports (preferably, the waste chamber A vent port **2512**A and waste chamber B vent port **2512**B) on a cartridge and allow the pump to be used to move fluid in the cartridge away or towards the selected vent ports.

[0311] The manifold is also connected to a pump vent line (comprising a pump vent line valve **2492**) for venting the pump manifold. The control valves have a closed position that seals the control line and the associated cartridge vent port, an open position that connects the pump to the cartridge vent port and, optionally, a vent position that opens the cartridge vent port to ambient pressure. The pump vent line valve has a closed position that seals the pump vent port and an open position that exposes the pump manifold to ambient pressure and releases pressure/vacuum in the pump manifold. The fluidic handling sub-system further comprises vent lines (comprising vent valves **2412**, **2422**, **2432**A and **2432**B) that allow venting of vent ports (sample chamber vent port **2512**, air port **2522**, reagent chamber A vent port **2532**A and reagent chamber B vent port **2532**B, respectively) on a cartridge (preferably, the cartridge vent ports other than the waste cartridge ports). The vent valves have a closed position that seals the associated cartridge vent port and an open position that exposes the vent port to ambient pressure. The fluidic handling sub-system may also comprise a pressure sensor couple to the pump manifold for detecting pressure in the manifold. During fluidic control of a cartridge, the pressure in the manifold is, preferably, monitored to ensure that it falls within expected pressure ranges for specific operations and confirm that the fluidic handling system is operating properly. The specific preferred valve configuration shown in FIG. **24** is designed to move fluid primarily by aspirating it towards the valve chambers. Other valve configurations, e.g., configurations that drive fluids primarily by positive pressure, will be readily apparent to the skilled artisan and may valves that allow chambers other than the waste chambers to be connected to the pump and/or that allow the waste chambers to be directly vented to the atmosphere.

[0312] In accordance with another aspect of the present invention, a preferred cartridge reader is provided, as illustrated in FIGS. **43**(*a*)-**43**(*g*). In this embodiment, a preferred cartridge reader receives the assay cartridge and moves the assay cartridge into a light-tight enclosure, where the amount of ambient light that enters the reader is minimized. A cartridge tray supports the assay cartridge on the bottom and a top mounting tray is guided to enable the assay cartridge to be accessed and analyzed by a plurality of reader components within the cartridge reader. A photodiode assembly having at least one photodiode is capable of moving in a direction that is substantially orthogonal to the direction of the assay cartridge to provide multiple degrees of freedom for the sampling of the assay cartridge.

[0313] Referring to FIGS. **43**(*a*)-(*g*), a preferred embodiment of a cartridge reader is illustrated, which describes preferred approaches to loading and aligning assay cartridges in the reader. In FIGS. **43**(*a*) and **43**(*b*), cartridge reader **4300** is shown for clarity without the external case or housing and without the walls that define a light-tight enclosure within cartridge reader **4300** (the locations of which are shown as a dotted line). The reader includes cartridge tray **4320** for holding cartridge **4380**, which may be a liquid sample or swab sample cartridge as described above, e.g., swab cartridge **3700** shown in FIG. **37**(*b*). Tray **4320** is mounted, via guide block **4324** onto linear rail **4314** to provide for linear motion of the tray in and out of the light-tight enclosure. While the motion of tray **4320** is preferably linear, it is not so limited and rail **4314** and motion of tray **4320** can be along any paths, including linear, segmented or curvilinear paths. Movement of tray **4320** along the rail is driven by motor **4310** which turns